24. A method for adaptively duplexing transmissions in a communication link using a time division duplexing scheme wherein transmissions are communicated in an uplink direction during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, comprising the steps of:

(a) determining an uplink bandwidth requirement and a downlink bandwidth requirement of the communication link, wherein the uplink and downlink bandwidth requirements are determined using associated and respective uplink and downlink bandwidth utilization parameters;

(b) calculating an uplink/downlink bandwidth requirement ratio based upon the uplink and downlink bandwidth requirements of the link;

(c) allocating uplink and downlink time slots in response to the calculated uplink/downlink bandwidth ratio; and

(d) periodically enabling uplink transmissions during the allocated uplink time slots and downlink transmissions during the allocated downlink time slots.

25. The method of Claim 24, wherein the uplink and downlink bandwidth requirements are initially determined when the link is installed in the communication system.

26. The method of Claim 24, wherein the uplink and downlink bandwidth requirements are determined by periodically monitoring the bandwidth utilization parameters for uplink and downlink transmissions in the communication link.

27. The method of Claim 24, wherein the uplink and downlink bandwidth requirements are determined by periodically monitoring requests for uplink and downlink transmissions in the communication link.

28. The method of Claim 24, wherein the bandwidth requirements are periodically determined and the associated uplink/downlink bandwidth requirement ratio for the link is periodically updated, and wherein the uplink and downlink time slot allocations are updated periodically in response to the updated uplink/downlink bandwidth ratio.

29. The method of Claim 28, wherein the uplink and downlink bandwidth requirements are periodically determined by continuously monitoring the transmissions in the communication link.

30.   The method of Claim 24, wherein the uplink and downlink bandwidth requirements vary depending upon the type of service provided over the communication link.

31.   The method of Claim 24, wherein the uplink and downlink bandwidth requirements vary depending upon the type of user of the communication link.

32.   The method of Claim 24, wherein the communication link comprises a wireless communication link.

33.   The method of Claim 24, wherein the uplink and downlink time slots are dynamically allocated using a frame-based time slot allocation approach.

34.   The method of Claim 33, wherein a frame comprises N time slots, and wherein the frame-based time slot allocation approach comprises allocating a first number N_1 time slots (where N is greater than or equal to N_1) for downlink transmissions only, and allocating the remaining N_2 time slots for uplink transmissions only (where N_2 equals $N-N_1$).

35.   The method of Claim 33, wherein a frame comprises N time slots, and wherein the frame-based time slot allocation approach comprises allocating a first number N_1 time slots (where N is greater than or equal to N_1) for downlink transmissions only, and allocating the remaining N_2 time slots for both uplink and downlink transmissions (where N_2 equals $N-N_1$).

36.   The method of Claim 33, wherein a frame comprises N time slots, and wherein the frame-based time slot allocation approach comprises allocating a first number N_1 time slots (where N is greater than or equal to N_1) for uplink transmissions only, and allocating the remaining N_2 time slots for downlink transmissions only (where N_2 equals $N-N_1$).

37.   The method of Claim 33, wherein a frame comprises N time slots, and wherein the frame-based time slot allocation approach comprises allocating a first number N_1 time slots (where N is greater than or equal to N_1) for uplink transmissions only, and allocating the remaining N_2 time slots for both uplink or downlink transmissions (where N_2 equals $N-N_1$).

38.   The method of Claim 24, wherein the uplink and downlink bandwidth requirements are determined using a plurality of associated uplink and downlink statistical bandwidth parameters.

39.   The method of Claim 38, wherein the statistical bandwidth parameters comprise both an initial and actual set of statistical parameters reflective of the bandwidth requirements of the communication link.

40.   The method of Claim 39, wherein the initial set of statistical parameters are set when the communication link is installed, and wherein the actual set of statistical parameters are periodically updated as the uplink and downlink bandwidth utilization of the communication link varies.

41.   The method of Claim 40, wherein the initial set of statistical parameters are based upon an estimate of the number of users and the type of user of the communication link.

42.   An apparatus for adaptively duplexing transmissions in a communication link of a wireless communication system using a time division duplexing scheme wherein transmissions are communicated in an uplink direction during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, comprising:

(a)   means for determining an uplink bandwidth requirement and a downlink bandwidth requirement of the communication link, wherein the uplink and downlink bandwidth requirements are determined using associated and respective uplink and downlink bandwidth utilization parameters;

(b)   means, responsive to the determining means, for calculating an uplink/downlink bandwidth requirement ratio based upon the uplink and downlink bandwidth requirements of the link;

(c)   means, responsive to the calculating means, for allocating uplink and downlink time slots; and

(d)   means for periodically enabling uplink transmissions during the allocated uplink time slots and downlink transmissions during the allocated downlink time slots.

43.   The apparatus of Claim 42, wherein the uplink and downlink bandwidth requirements are determined by periodically monitoring the bandwidth utilization parameters for uplink and downlink transmissions in the communication link.

-4-

44. The apparatus of Claim 42, wherein the uplink and downlink bandwidth requirements are determined by periodically monitoring requests for uplink and downlink transmissions in the communication link.

45. The apparatus of Claim 42, wherein the determining, calculating and allocating means comprise a computer program executing on a programmable processor.

46. The apparatus of Claim 45, wherein the programmable processor is in a cluster controller, and wherein the cluster controller controls a plurality of base stations in the wireless communication system, and wherein one selected base station controls transmissions in the communication link.

47. The apparatus of Claim 46, wherein the communication link comprises a wireless communication between the selected base station and a CPE.

48. A method for duplexing transmissions in a communication link using a time division duplexing scheme wherein transmissions are communicated in an uplink direction during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, comprising the steps of:

(a) determining uplink and downlink bandwidth requirements in accordance with associated and respective quality of service parameters to establishing an uplink/downlink bandwidth requirement ratio;

(b) allocating uplink and downlink time slots in response to the uplink/downlink bandwidth ratio; and

(c) periodically enabling uplink transmissions during the allocated uplink time slots and downlink transmissions during the allocated downlink time slots.

49. The method of Claim 46, wherein the uplink and downlink bandwidth requirements are determined when the link is installed in the communication system.

50. The method of Claim 46, wherein the uplink and downlink bandwidth requirements vary depending upon the type of service provided over the communication link.

51. The method of Claim 46, wherein the uplink and downlink bandwidth requirements vary depending upon the type of user of the communication link.

52.   A method for forming a communication link between a base station and at least one customer premises equipment (CPE) using an adaptive time division duplexing scheme wherein transmissions are communicated in fixed-length frames of information, each fixed-length frame of information includes an uplink subframe and a downlink subframe, the method comprising:

receiving bandwidth requests at the base station for bandwidth on the uplink subframe;

apportioning the fixed-length frame between the uplink subframe and the downlink subframe in accordance with the bandwidth requests; and

notifying the at least one CPE as to how the fixed-length frame was apportioned.

53.   The method of Claim 52, wherein analyzing the requests is performed to maximize the usable bandwidth of the fixed-length frame.

54.   The method of Claim 52, wherein analyzing the requests includes determining the uplink subframe bandwidth for a previous fixed-length frame.

55.   The method of Claim 52, wherein analyzing the requests includes determining the downlink subframe bandwidth for a previous fixed-length frame.

56.   The method of Claim 52, wherein analyzing the requests includes determining the potential bandwidth requirements of at least one of the requests from the at least one CPE.

57.   The method of Claim 52, wherein selecting portions of the fixed-length frame includes periodically monitoring requests for uplink and downlink transmissions in the communication link.

58.   The method of Claim 52, wherein the uplink subframe and downlink subframe bandwidth requirements vary depending upon the type of service provided over the communication link.

59.   The method of Claim 52, wherein the uplink subframe and the downlink subframe bandwidth requirements vary depending upon the type of user of the communication link.

60.   The method of Claim 52, wherein the communication link comprises a wireless communication link.

61.   The method of Claim 52, wherein the uplink subframe and the downlink subframe bandwidth requirements are determined when the communication link is installed in the communication system.

62.   A method for communicating between a base station and at least one CPE using an adaptive time division duplexing scheme wherein transmissions are communicated in frames of data and wherein each frame of data includes an uplink frame and a downlink frame, the method comprising:

           receiving bandwidth requests at the base station;

           processing the bandwidth requests with the uplink frame and the downlink frame;

           selecting portions of the frame of data for the uplink frame and the downlink frame in accordance with the processing; and

           transmitting data between the base station and the at least one CPE using the frame of data.

63.   The method of Claim 62, wherein the bandwidth requests include requests for the uplink frame.

64.   The method of Claim 63, wherein processing the bandwidth requests includes summing the bandwidth requests for the uplink frame.

65.   The method of Claim 62, wherein the bandwidth requests include requests for the downlink frame.

66.   The method of Claim 62, wherein selecting portions of the frame of data is performed to maximize the usable bandwidth of the frame of data.

67.   The method of Claim 62, wherein selecting portions of the frame of data includes determining the uplink frame bandwidth for a previous frame of data.

68.   The method of Claim 62, wherein selecting portions of the frame of data includes determining the downlink frame bandwidth for a previous frame of data.

69.   The method of Claim 62, wherein selecting portions of the frame of data includes determining the potential bandwidth requirements of at least one of the requests from the at least one CPE.

70.   A method for monitoring and updating uplink and downlink bandwidth requirements in a wireless communication system including a base station and at least one CPE, the method comprising:

initializing the base station with an initial set of bandwidth utilization parameters, including a first estimate of the uplink and downlink bandwidth requirements of at least one CPE;

monitoring bandwidth use by the at least one CPE and the base station; and

updating the initial set of bandwidth utilization parameters with an actual set of bandwidth utilization parameters based on the monitoring.

71.   The method of Claim 70, wherein updating the initial set of bandwidth utilization parameters includes determining a second estimate of the uplink and downlink bandwidth requirements of the at least one CPE.

72.   A method for communicating between a base station and at least one CPE using a series of uplink and downlink frames of information in an adaptive time division duplexing scheme, the method comprising:

receiving a request for bandwidth of a subsequent uplink frame and of a subsequent downlink frame from at least one CPE, wherein the duration of the downlink frame request exceeds the uplink frame request;

extending the subsequent downlink frame and reducing the subsequent uplink frame by a similar portion of time, such that the total duration of the subsequent uplink and downlink frames is unchanged; and

notifying the at least one CPE as to the durations of the extended downlink frame and of the shortened uplink frame.

73.   A method for adaptively duplexing transmissions in a communication link using a time division duplexing scheme wherein transmissions are communicated in an uplink direction during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, the method comprising:

determining an initial uplink bandwidth requirement and an initial downlink bandwidth requirement of the communication link;

calculating an initial uplink/downlink bandwidth requirement ratio based upon the initial uplink and initial downlink bandwidth requirements of the link;

allocating initial uplink and downlink time slots in response to the calculated initial uplink/downlink bandwidth ratio;

transmitting information during the initial uplink and downlink time slots;

determining an actual uplink bandwidth requirement and an actual downlink bandwidth requirement based on the transmission during the initial uplink and downlink time slots;

calculating an actual uplink/downlink bandwidth requirement ratio based upon the actual uplink and actual downlink bandwidth requirements of the link;

allocating actual uplink and downlink time slots in response to the calculated actual uplink/downlink bandwidth ratio; and

transmitting information during the actual uplink and downlink time slots.

74. A wireless communication system for transmitting frames of data wherein each frame of data includes an uplink subframe portion and a downlink subframe portion using adaptive time division duplexing, the system comprising:

at least one CPE configured to demodulate the downlink subframe portion and modulate the uplink subframe portion; and

a base station configured to demodulate the uplink subframe portion and modulate the downlink subframe portion, wherein the lengths of the uplink and downlink subframe portions are based on the uplink bandwidth requirement of the at least one CPE and the downlink bandwidth requirement of the base station.

75. The system of Claim 74, wherein the uplink bandwidth requirement is based on a previous uplink bandwidth requirement of the at least one CPE.

76. The system of Claim 74, wherein the uplink bandwidth requirement is based on a selected quality of service for the at least one CPE.

77. The system of Claim 74, wherein the uplink bandwidth requirement is based on current bandwidth requests from the at least one CPE.

78.   A method for monitoring and updating uplink and downlink bandwidth requirements for a communication link using a time division duplexing scheme wherein transmissions are communicated in an uplink direction during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, comprising:

(a)   determining an initial set of bandwidth utilization parameters, wherein the initial bandwidth utilization parameters comprise an estimate of the uplink and downlink bandwidth requirements; and

(b)   updating the initial set of bandwidth utilization parameters with an actual set of bandwidth utilization parameters reflective of an actual bandwidth utilization of the uplink and downlink time slots, wherein the actual set of bandwidth parameters are calculated as follows:

$$\begin{pmatrix} U^{(M)}_{n+1} \\ D^{(M)}_{n+1} \end{pmatrix} = \alpha_M \begin{pmatrix} U^{(M)}_{n} \\ D^{(M)}_{n} \end{pmatrix} + (1-\alpha_M) \begin{pmatrix} \left(U_n - U^{(1)}_n\right)^M \\ \left(D_n - D^{(1)}_n\right)^M \end{pmatrix} \quad \text{wherein } \alpha_M < 1,\ M > 1$$

$$\begin{pmatrix} U^{(1)}_{n+1} \\ D^{(1)}_{n+1} \end{pmatrix} = \alpha_1 \begin{pmatrix} U^{(1)}_{n} \\ D^{(1)}_{n} \end{pmatrix} + (1-\alpha_1) \begin{pmatrix} U_n \\ D_n \end{pmatrix} \quad \text{and wherein } \alpha_1 < 1,\ M = 1;$$

and wherein $U^{(M)}_n$, $D^{(M)}_n$ comprise uplink and downlink filtered moments, respectively, of order M at an instant n, and wherein U_n, D_n respectively comprise an uplink and downlink accumulated bandwidth requirement influenced by the actual bandwidth utilization.

79.   The method of Claim 78, wherein the initial set of bandwidth utilization parameters is periodically updated with the actual set of bandwidth parameters calculated in step (b).

80.   The method of Claim 78, further comprising monitoring rejected transmissions, wherein the following parameters are updated when transmissions are rejected:

$$\begin{pmatrix} U'_{n+1} \\ D'_{n+1} \end{pmatrix} = \gamma_1 \begin{pmatrix} U'_{n} \\ D'_{n} \end{pmatrix} + (1-\gamma_1) \begin{pmatrix} \delta U \\ \delta D \end{pmatrix} \quad \text{wherein } \gamma_1 < 1;$$

and wherein U'_n, D'_n comprise a moving average of the uplink and downlink bandwidth requirements of rejected sessions.
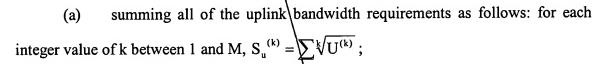
81. The method of Claim 78, further comprising monitoring rejected transmissions, wherein the following parameters are updated when transmissions are not rejected:

$$\begin{pmatrix} U'_{n+1} \\ D'_{n+1} \end{pmatrix} = \gamma_2 \begin{pmatrix} U'_n \\ D'_n \end{pmatrix} \quad \gamma_2 < 1;$$

and wherein U'_n, D'_n comprise a moving average of the uplink and downlink bandwidth requirements of rejected sessions.

82. A method for monitoring and updating uplink and downlink bandwidth requirements for transmissions across a communication link in a wireless communication system, wherein the transmissions occur during frames comprising N time slots wherein N_1, N_2, ... N_M are positive integers, and wherein $\sum_{k=1}^{M} N_k = N$, comprising:

(a) summing all of the uplink bandwidth requirements as follows: for each integer value of k between 1 and M, $S_u^{(k)} = \sum \sqrt[k]{U^{(k)}}$;

(b) summing all of the downlink bandwidth requirements as follows: for each integer value of k between 1 and M, $S_d^{(k)} = \sum \sqrt[k]{D^{(k)}}$;

(c) calculating an estimated bandwidth allocation scheme as follows:

$$\hat{N}_d = INT\left[\sum_{k=1}^{M} \frac{N_k S_d^{(k)}}{S_d^{(k)} + S_u^{(k)}} \right], \quad \hat{N}_u = N - \hat{N}_d ;$$

(d) comparing the estimated bandwidth allocation scheme calculated in step (c) with the allocation scheme currently used, wherein the allocation scheme currently used is defined as N_d, N_u; and

(e) replacing N_d and N_u with the estimated bandwidth allocation scheme calculated in step (c) if $\left| N_d - \hat{N}_d \right| \geq \mu$, wherein μ comprises a pre-determined threshold.

83. The method of Claim 82, further comprising monitoring rejected transmissions.

84. The method of Claim 83, wherein monitoring transmissions comprises:

summing all of the rejected uplink bandwidth requirements as follows: $S'_u = \sum U'$;

summing all of the rejected downlink bandwidth requirements as follows: $S_d' = \sum D'$; and

calculating an expected allocation scheme as follows: $\begin{pmatrix} \widetilde{N}_u \\ \widetilde{N}_d \end{pmatrix} = \frac{1}{S'_d + S'_u} \begin{pmatrix} S'_u \\ S'_d \end{pmatrix}.$

85. The method of Claim 84, further comprising updating the bandwidth allocation scheme when the number of rejected transmissions exceeds a predetermined threshold.

86. The method of Claim 85, wherein the bandwidth allocation scheme is updated in accordance with the following:

(a) determining *if* $Max(S_u', S_d') > S_o$, wherein S_o is a constant, if so then proceeding to step (b);

(b) determining *if* $|N_d - \widetilde{N}_d| > \mu$, wherein μ is a constant, if so then proceeding to step (c);

(c) determining *if* $\widetilde{N}_d > N_d$ and $N_d < N - \delta$, wherein δ is a constant, if so then updating the downlink allocation N_d as follows: $N_d \leftarrow N_d + \delta$;

(d) determining *if* $\widetilde{N}_d < N_d$ and $N_d > \delta$, if so then updating the downlink allocation N_d as follows: $N_d \leftarrow N_d - \delta$;

(e) updating the uplink allocation N_u whenever the downlink allocation is updated in either steps (c) or (d) as follows: $N_u \leftarrow N - N_u$; and

(f) updating the bandwidth allocation parameters whenever the values of N_d and N_u are updated.

87. The method of Claim 86, further comprising alerting the wireless communication system if $Max(S_u', S_d') > T$, wherein T is a predetermined threshold value.

88. A method for adaptively duplexing transmissions between a base station and at least one CPE using a series of uplink and downlink frames of information in an adaptive time division duplexing scheme, wherein transmissions are communicated in an uplink direction

during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, comprising:

selecting a first service type for an uplink transmission;

selecting a second service type for a downlink transmission;

determining an uplink bandwidth requirement that is associated with the selected first service type;

determining a downlink bandwidth requirement that is associated with the selected second service type;

calculating an uplink/downlink bandwidth requirement ratio based upon the uplink and downlink bandwidth requirements;

allocating uplink and downlink time slots in response to the calculated uplink/downlink bandwidth ratio; and

periodically enabling uplink transmissions during the allocated uplink time slots and downlink transmissions during the allocated downlink time slots.

89.   The method of Claim 88, wherein the first service type is sensitive to transmission delays and the second service type is insensitive to transmission delays.

90.   The method of Claim 88, further comprising comparing sensitivities to a transmission delay for the first service type and the second service type.

91.   The method of Claim 90, further comprising shifting the uplink/downlink bandwidth requirement ratio to reduce the transmission delay of the first service type at the expense of increasing the transmission delay of the second service type.

92.   A method for adaptively duplexing transmissions in a communication link using a time division duplexing scheme wherein transmissions are communicated in an uplink direction during uplink time slots and wherein transmissions are communicated in a downlink direction during downlink time slots, the method comprising:

selecting a quality of service associated with the communication link;

determining an initial uplink bandwidth requirement and an initial downlink bandwidth requirement of the communication link based on the selected quality of service;

calculating an initial uplink/downlink bandwidth requirement ratio based upon the initial uplink and initial downlink bandwidth requirements of the link;

allocating initial uplink and downlink time slots in response to the calculated initial uplink/downlink bandwidth ratio;

transmitting information during the initial uplink and downlink time slots;

determining an actual uplink bandwidth requirement and an actual downlink bandwidth requirement based on actual bandwidth utilization during the initial uplink and downlink time slots;

calculating an actual uplink/downlink bandwidth requirement ratio based upon the actual uplink and actual downlink bandwidth requirements of the link;

allocating actual uplink and downlink time slots in response to the calculated actual uplink/downlink bandwidth ratio; and

transmitting information during the actual uplink and downlink time slots.

93.   The method of Claim 92, wherein the initial uplink bandwidth requirement and the initial downlink bandwidth requirement split the uplink time slots and the downlink time slots into equal portions.

94.   The method of Claim 92, wherein the initial uplink bandwidth requirement and the initial downlink bandwidth requirement split the uplink time slots and the downlink time slots into unequal portions.

95.   The method of Claim 94, further comprising calculating the actual uplink/downlink bandwidth requirement ratio based on the selected quality of service.

96.   The method of Claim 92, wherein the selected quality of service is based on type of service and data latency requirements.